Stoller
Grand Junction Office established 1959

GJO-2003-530-TAC

C4196
Log Data Report

Borehole Information:

Borehole: C4196			**Site:** 216-B-26 Trench		
Coordinates (WA State Plane)		**GWL (ft)[1]:** Not reached		**GWL Date:** 11/14/2003	
North	**East**	**Drill Date**	**TOC[2] Elevation**	**Total Depth (ft)**	**Type**
n/a[3]	n/a	Nov. 2003	n/a	40	Percussion

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0	6 5/8	5 5/8	1/2	0	
The logging engineer used a caliper to determine the outside casing diameter. The caliper and inside casing diameter were measured using a steel tape. Measurements were rounded to the nearest 1/16 in. Casing thickness was calculated.						

Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drill pipe. The ground surface between 0 and about 1 ft is compacted gravel that was trucked in to stabilize the ground surface for drilling and logging operations.

Logging Equipment Information:

Logging System:	Gamma 2A		**Type:** 35% HPGe (34-TP20863A)
Calibration Date:	09/2002	**Calibration Reference:**	GJO-2002-383-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 1G		**Type:** 35% HPGe (34-TP10967A)
Calibration Date:	04/2003	**Calibration Reference:**	GJO-2002-438-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 1C		**Type:** High Rate Detector
Calibration Date:	04/2003	**Calibration Reference:**	GJO-2003-429-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 2F		**Type:** Moisture (H380932510)
Calibration Date:	09/2003	**Calibration Reference:**	GJO-2003-520-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3/Repeat	4	5/Repeat
Date	11/17/03	11/18/03	11/18/03	11/24/03	11/24/03
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	39.0	16.0	7.0	39.0	26.0
Finish Depth (ft)	15.0	1.0	3.0	15.0	22.0
Count Time (sec)	200	200	200	200	200
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0	1.0
ft/min	N/A[4]	N/A	N/A	N/A	N/A
Pre-Verification	BA218CAB	BA220CAB	BA220CAB	AG024CAB	AG024CAB
Start File	BA219000	BA221000	BA221016	AG024000	AG024025
Finish File	BA219024	BA221015	BA221020	AG024024	AG024029
Post-Verification	BA219CAA	BA221CAA	BA221CAA	AG024CAA	AG024CAA
Depth Return Error (in.)	0	0	0	N/A	0
Comments	No fine-gain adjustment.	Fine-gain adjustment made before logging.	Repeat section.	No fine-gain adjustment.	Repeat section.

High Rate Logging System (HRLS) Log Run Information:

Log Run	1	2/Repeat			
Date	11/26/03	11/26/03			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	16.0	14.0			
Finish Depth (ft)	11.0	12.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	AC084CAB	AC084CAB			
Start File	AC084000	AC084006			
Finish File	AC084005	AC084008			
Post-Verification	AC085CAA	AC085CAA			
Depth Return Error (in.)	N/A	0			
Comments	No fine-gain adjustment.	Repeat section.			

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2/Repeat		
Date	11/17/03	11/17/03		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	0.0	10.0		
Finish Depth (ft)	39.5	14.0		
Count Time (sec)	N/A	N/A		
Live/Real	N/A	N/A		
Shield (Y/N)	N/A	N/A		

Log Run	1	2/Repeat		
MSA Interval (ft)	0.25	0.25		
ft/min	1.0	1.0		
Pre-Verification	BF116CAB	BF116CAB		
Start File	BF116000	BF116159		
Finish File	BF116158	BF116175		
Post-Verification	BF116CAA	BF116CAA		
Depth Return Error (in.)	N/A	0		
Comments	None	Repeat section.		

Logging Operation Notes:

Zero reference was the ground surface, and the borehole was logged through drill pipe. Logging was performed with a centralizer installed on the sondes.

SGLS data were collected using Gamma 2A and Gamma 1G. Pre- and post-survey verification measurements employed the Amersham KUT (^{40}K, ^{238}U, and ^{232}Th) verifier with serial number 082 for Gamma 2A and Amersham KUT verifier with serial number 118 for Gamma 1G. On 11/17/2003, peak counts per second (cps) for ^{232}Th (2614 keV) were below acceptance criteria for pre-survey verification file BA218CAB, and this portion of the borehole was relogged with Gamma 1G.

HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements employed the ^{137}Cs verifier with serial number 1013.

Analysis Notes:

Analyst:	Sobczyk	Date:	12/03/03	Reference:	GJO-HGLP 1.6.3, Rev. 0

SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits. All of the verification spectra were within the acceptance criteria. The peak counts per second (cps) at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra as compared to the pre-run verification spectra for each day were between 1.3 percent lower and 5.7 percent higher at the end of the day.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of the day. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. The post-run verification spectrum was within the control limits while the pre-run verification spectrum recorded 749 cps versus the upper control limit of 735 cps.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G2AFeb03.xls and G1GMay03.xls for the SGLS and G1CApr03.xls for the HRLS). Zero reference was the ground surface. Based on measurements supplied by the driller, the casing configuration was assumed to be one string of 6-in. casing to total logging depth (39 ft). The SGLS and HRLS casing correction factors were calculated using a 6-in. casing thickness of 0.5 in. This casing thickness is based upon the field measurement. Water corrections were not required.

Using the SGLS, dead time greater than 40 percent was encountered in the interval from 12 to 15 ft, and data from this region are considered unreliable. At SGLS dead time greater than 40 percent, peak spreading

and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time corrections were applied when dead time surpassed 10.5 percent. The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. The volume fraction of water was calculated in EXCEL, using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. The neutron moisture calibration is based on a typical 6-in. casing with a thickness of 0.28 in., and the neutron moisture values were corrected for the 0.5-in. casing thickness.

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, gross gamma and volume fraction of water, naturally occurring radionuclides (^{40}K, ^{238}U, and ^{232}Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations on the combination plot rather than the ^{214}Bi peak at 609 keV because it exhibited slightly higher net counts per second.

Results and Interpretations:

^{137}Cs and ^{125}Sb were the man-made radionuclides detected in this borehole. ^{137}Cs was detected throughout the entire length of the borehole at concentrations ranging from the MDL (0.2 pCi/g) to 60,300 pCi/g. The maximum concentration of ^{137}Cs was measured at 13 ft. ^{125}Sb (based on 601 keV) was detected at 21 and 25 ft with concentrations of 1.3 and 1.7 pCi/g, respectively. Photopeaks at 428 keV and 601 keV (indicative of ^{125}Sb) were apparent on spectra between log depths of 21 and 25 ft. These photopeaks were not always statistically significant. ^{125}Sb (based on 428 keV) was detected at 23.7 ft on the repeat log with a concentration of 1.8 pCi/g.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS, SGLS, and NMLS data. ^{137}Cs (662 keV) concentrations are comparable between the repeat and original HRLS log runs. The natural radionuclides at energy levels of 609, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs. ^{137}Cs (662 keV) concentrations are comparable between the repeat and original SGLS log runs. The ^{125}Sb (based on 601 keV) did not repeat at 25 ft. ^{125}Sb (based on 428 keV) was detected on the repeat log run at 23.7 ft, but ^{125}Sb (based on 428 keV) was not encountered at 24 ft on the original log run. The neutron-moisture and its repeat are within the acceptance criteria.

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[1] GWL – groundwater level
[2] TOC – top of casing
[3] n/a – not available
[4] N/A – not applicable

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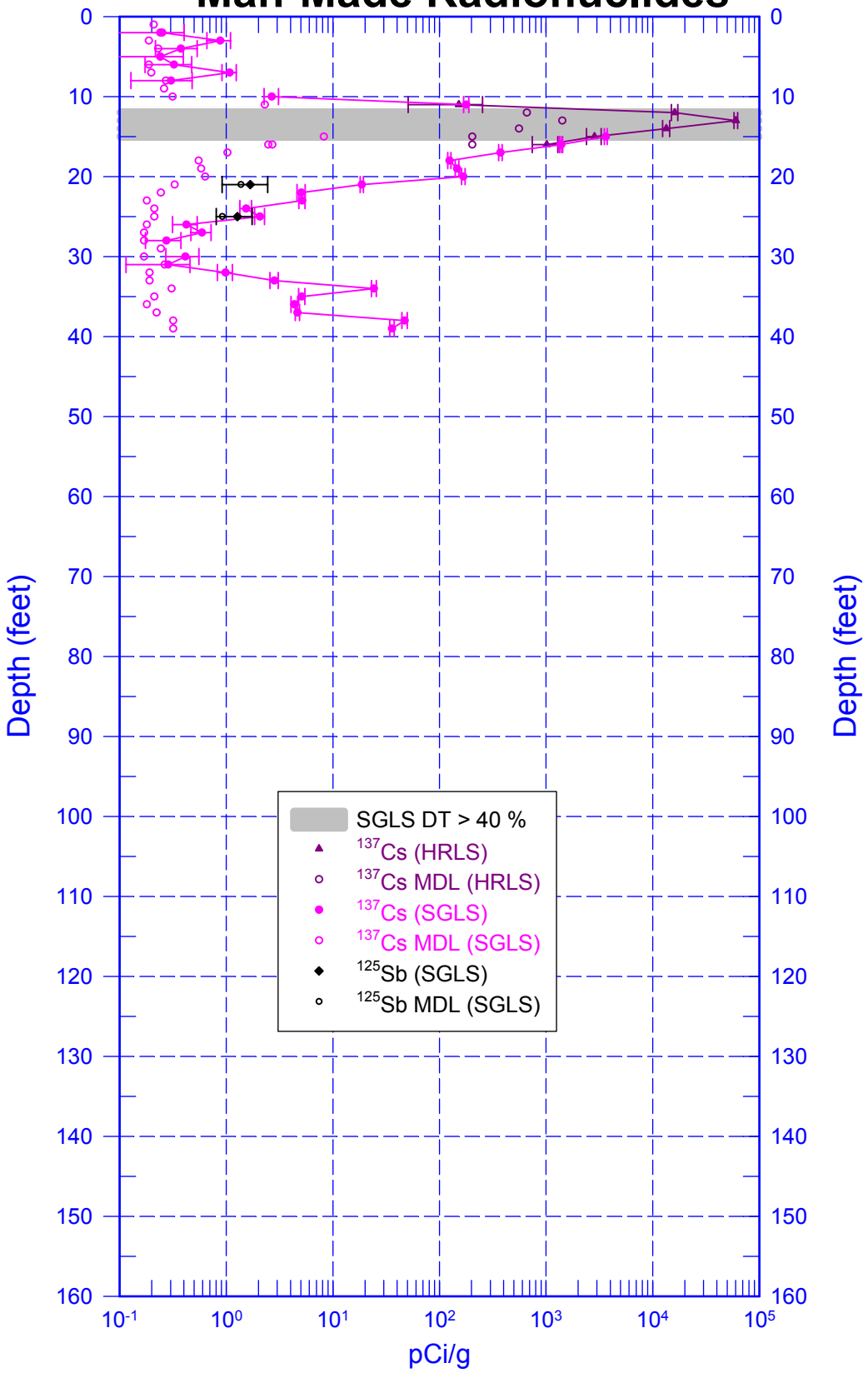
Man-Made Radionuclides



Zero Reference = Ground Surface

Date of Last Logging Run
11/26/2003

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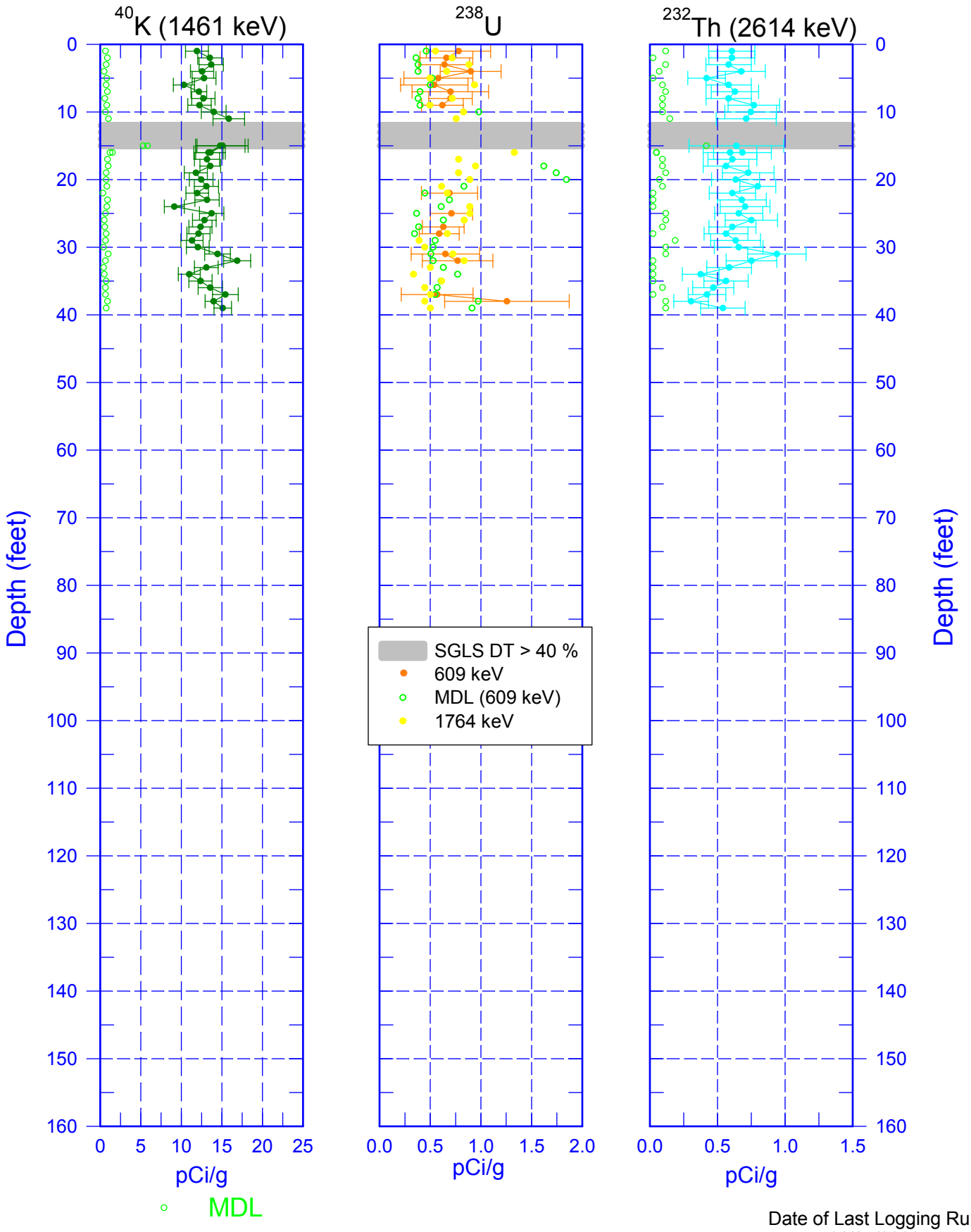
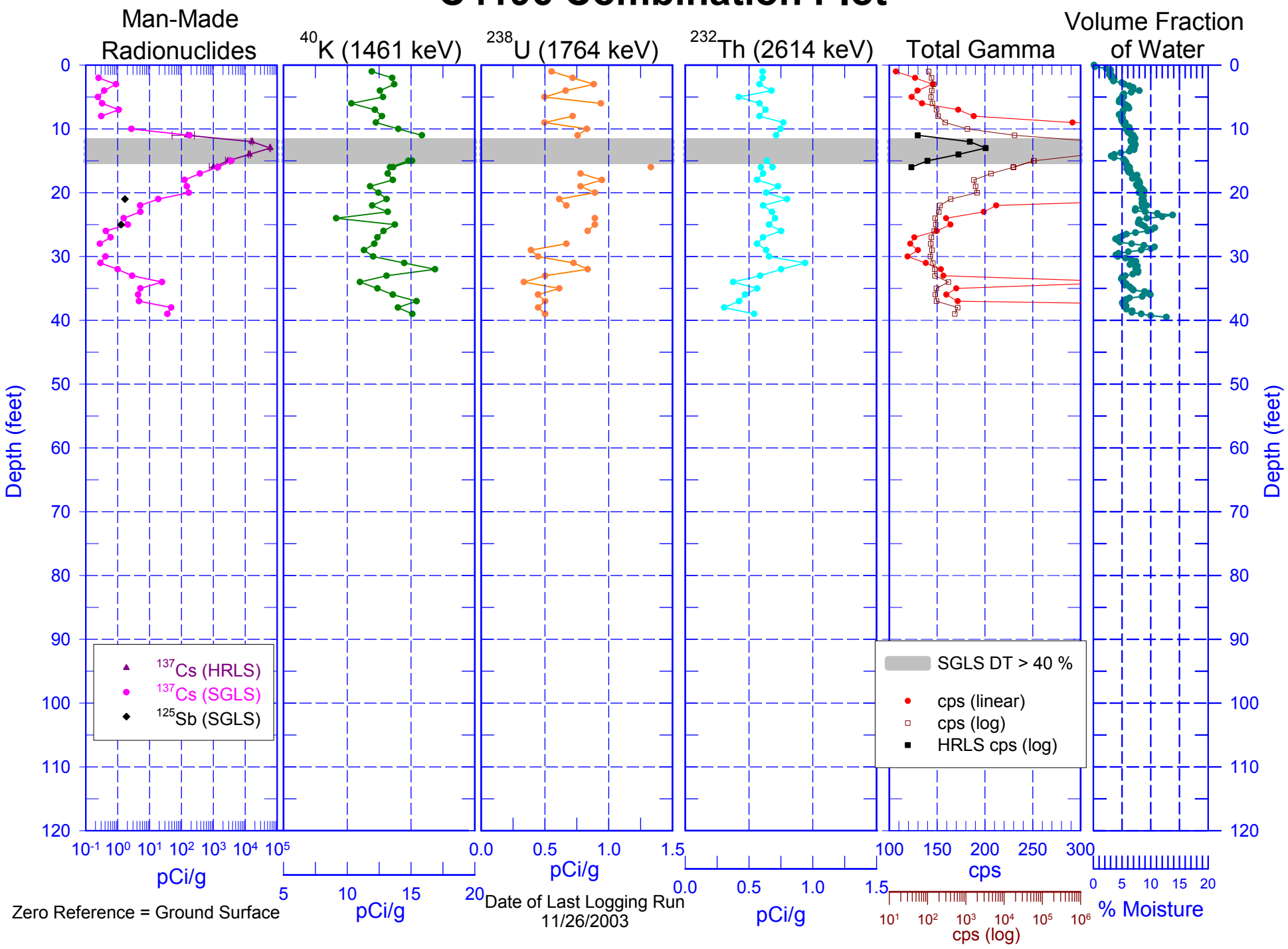
Natural Gamma Logs

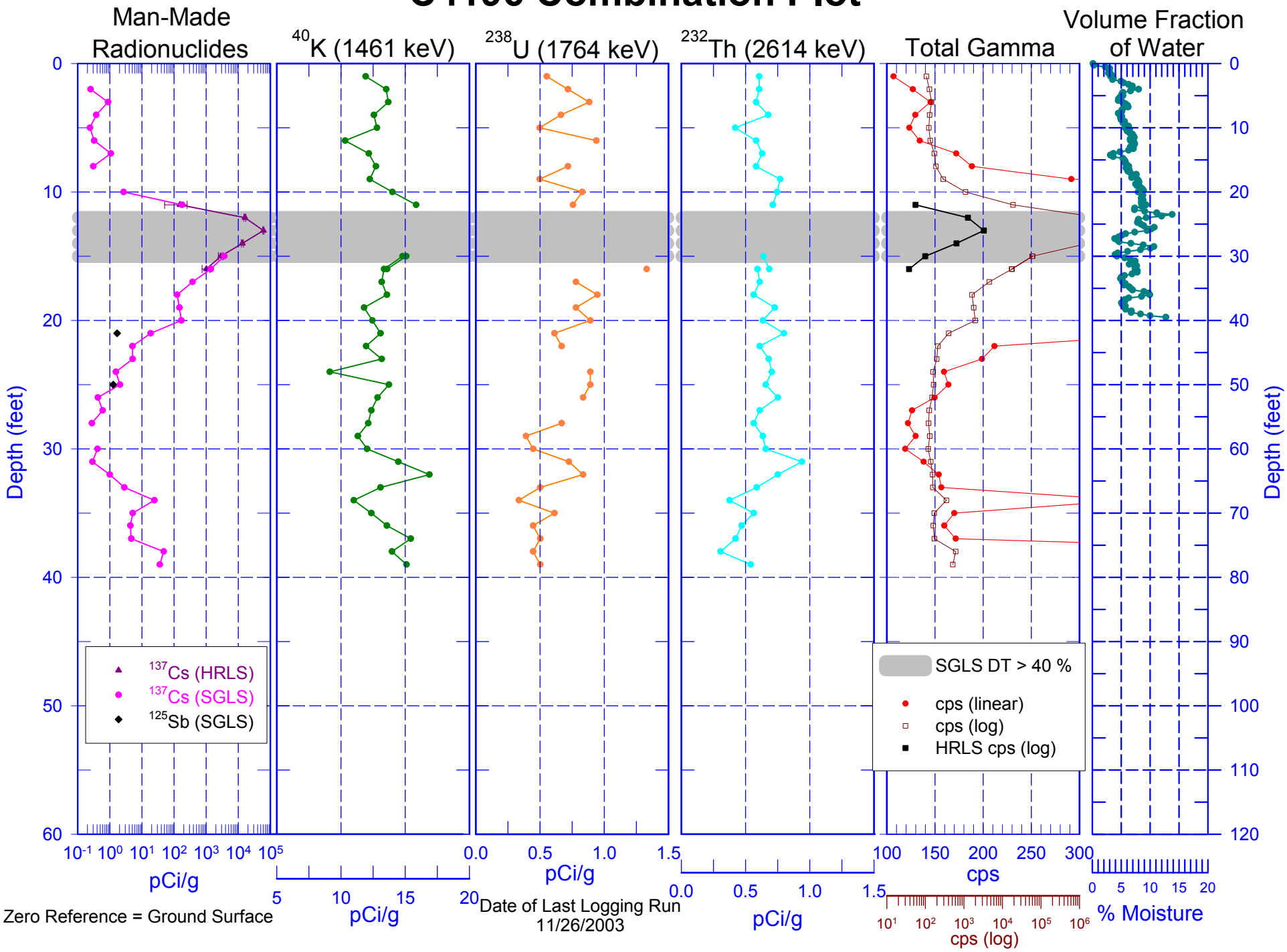


Zero Reference = Ground Surface

Date of Last Logging Run
11/24/2003


C4196 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Volume Fraction of Water
Depth (feet)
137Cs (HRLS)
137Cs (SGLS)
125Sb (SGLS)
SGLS DT > 40 %
cps (linear)
cps (log)
HRLS cps (log)
pCi/g
cps
cps (log)
% Moisture
Zero Reference = Ground Surface
Date of Last Logging Run
11/26/2003

C4196 Combination Plot



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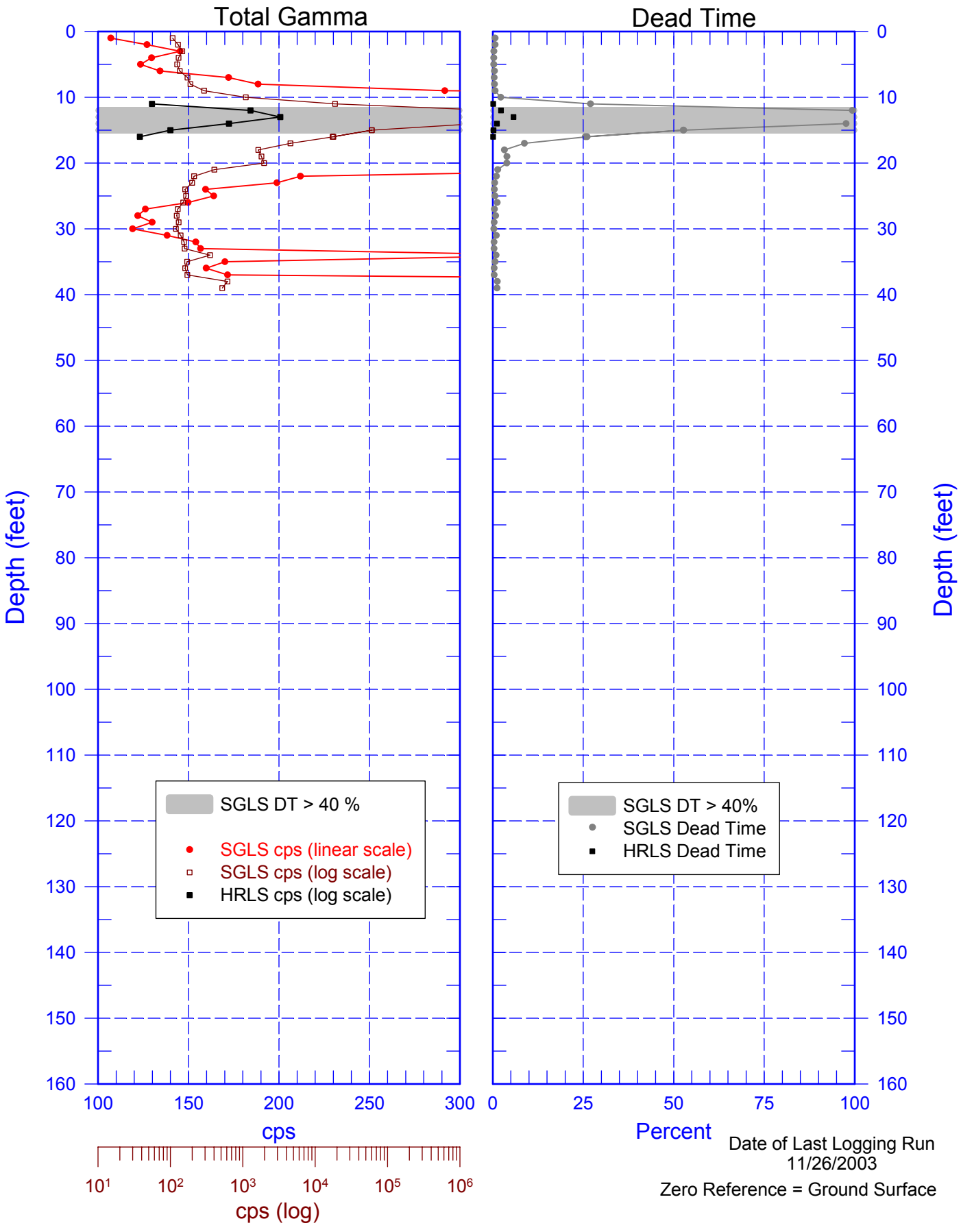
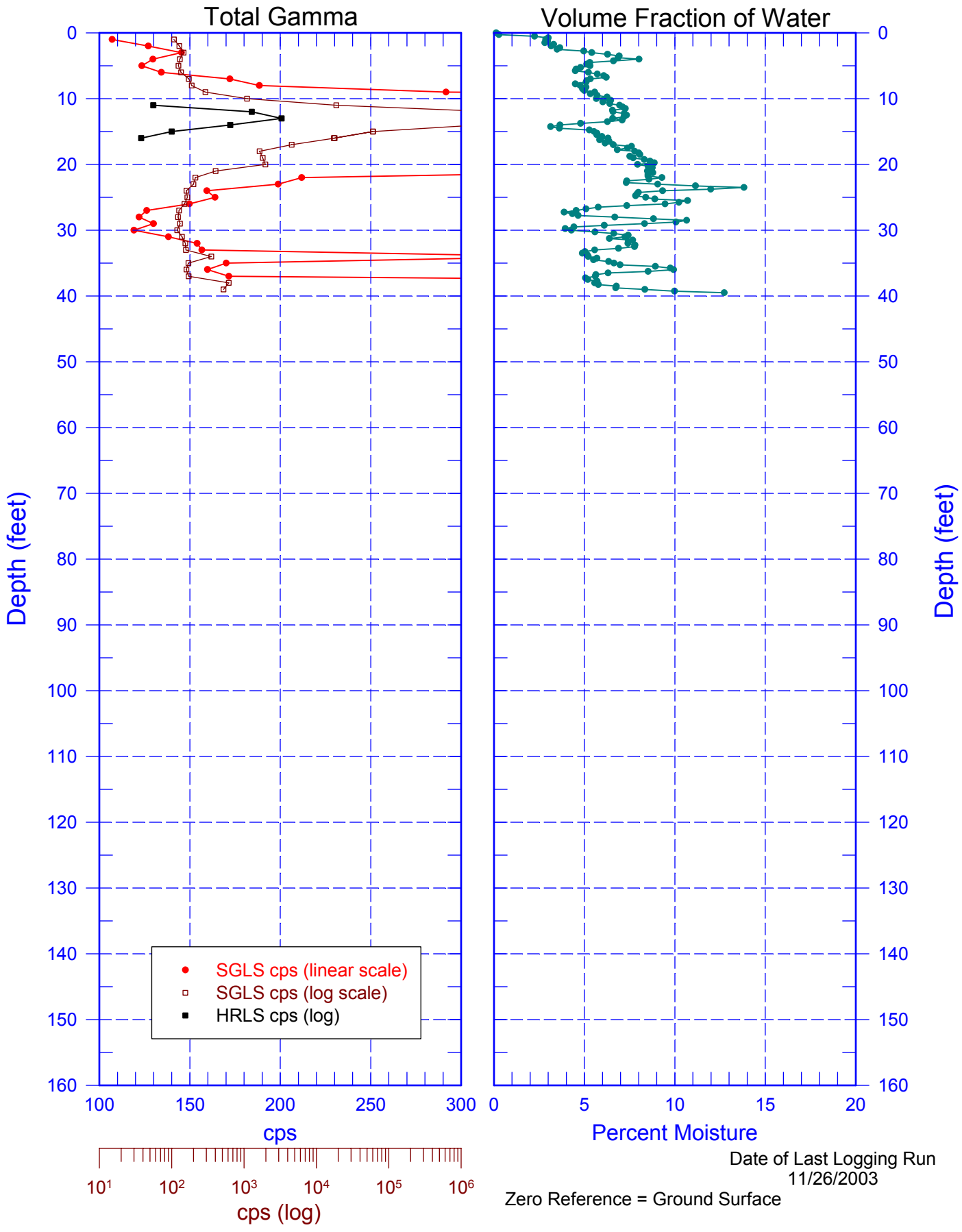
Total Gamma & Dead Time



Date of Last Logging Run
11/26/2003

Zero Reference = Ground Surface

C4196
Total Gamma & Neutron



Date of Last Logging Run
11/26/2003

Zero Reference = Ground Surface

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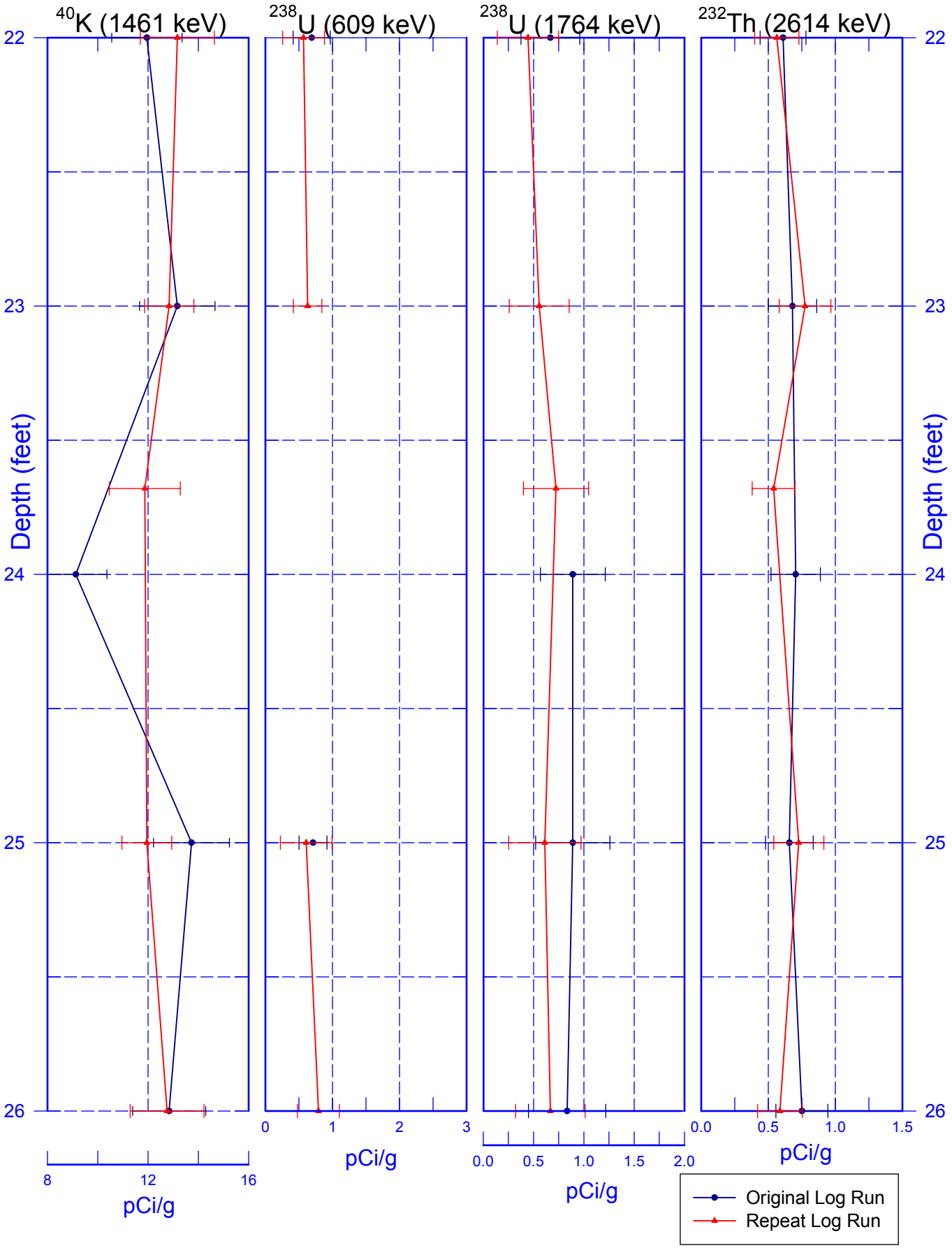
Rerun of Natural Gamma Logs (26.0 to 22.0 ft)



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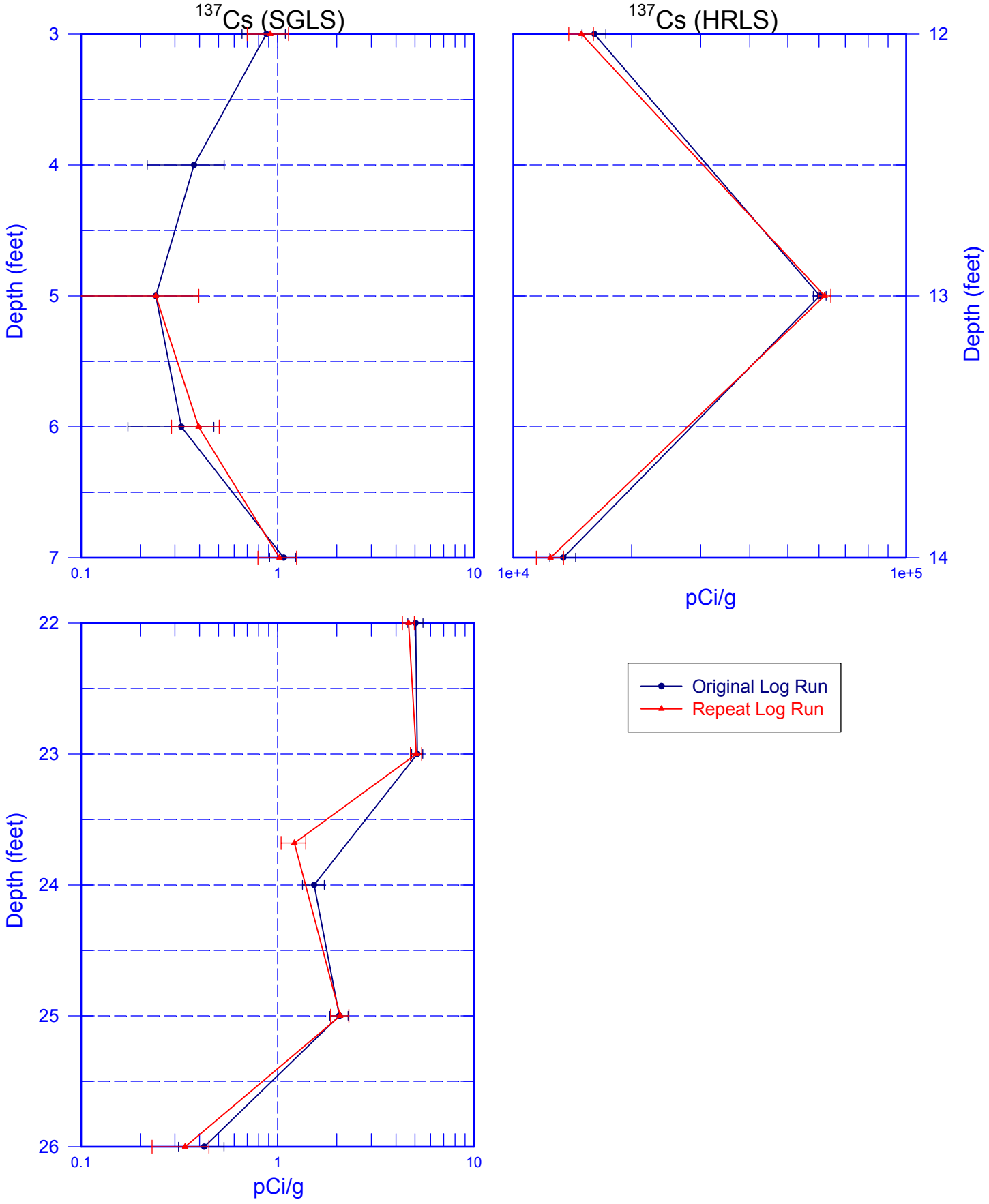
Rerun of Man-Made Radionuclides



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Rerun of Neutron-Moisture Log (10.0 to 14.0 ft)